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Vaclav Smil, 2017, *Energy and Civilization – A History*

MIT Press: Cambridge, MA. 552 pp.

Many books have misleading titles, claiming more than they deliver, but not this one. Although the title is extraordinarily ambitious, the book fulfils its bold promise, providing nothing less than a comprehensive account of the role of energy in the long history of human civilization, from ancient times right up to the present day. This is a rare but important perspective. Energy is a fundamental requirement of human existence, 'the only universal currency' (as the opening line puts it), and this book powerfully demonstrates that it has played - and continues to play - a hugely influential role in the unfolding story of *Homo sapiens* on Planet Earth. Yet few historians pay the slightest attention to this fundamental parameter of societal development. *Energy and Civilization* is a monumental corrective to this blind spot. With the text running to 460 pages, followed by 70 pages of small-font references, the book traces the 'energy thread' through history in revealing, insightful and fascinating detail. It feels like the culmination of a lifetime's work - grand in ambition and vast in scope - and a short review cannot possibly do it justice. Vaclav Smil has been publishing important work on aspects of energy for over four decades, including no less than 40 books, and so he speaks with very considerable authority, not to mention encyclopaedic knowledge - globally and historically. His earlier *magnum opus, Energy in World History,* was published in 1994 and became a standard text. The present volume substantially expands and extends the coverage, reflecting the transformations of the global energy context and the associated burgeoning of energy studies in the intervening years. It is clearly written, extensively illustrated and replete with explanatory tables, charts and boxes. In a few places there are 'note form' phrases, typos and ungainly sentences which have escaped the editorial eye, but these are few and far between.

The book begins - necessarily, perhaps, but somewhat unengagingly - by providing the framework of energy fundamentals, the basic concepts and measures of energy flows, stores, controls and conversions. It then dives deep into pre-history, exploring the energy dimensions of foraging societies and primitive agriculture, before examining in detail how traditional farming provided the nutritional needs for the early civilizations of Egypt, China,

the Americas and Europe. The 100 pages of Chapter 4 cover the long pre-industrial era, describing the various innovations in the energetics of power, fuel, transport, construction, metallurgy and warfare which shaped societies. The book then arrives at the great historical fulcrum which ushered in the modern world, the transition from phytomass fuels to fossil fuels and electricity, and from animate to mechanical prime movers. The rich vein of discoveries and technical innovations during and after the Industrial Revolution is illuminated step by step. Chapter 6, 'Fossil-Fueled Civilization', reflects on the extraordinary and accelerating pace of change in the uses of energy in every sector of modern societies, looking in turn at agriculture, industry, transport, information technology and economic growth. This leads into an interesting consideration of the consequences of these changes for urban life, politics, warfare, the environment and quality of life. The final chapter, borrowing the title of the 1994 book, stands back and considers the grand patterns - the different eras of energy use and the transitions from one to the next, the long-term trends and also the things which have not changed. The concluding section explores the balance between determinism and choice - just how significant is energy in shaping world history?

Most people, even specialists, cannot fail to learn a lot from reading this book. My own copy is extensively highlighted because few pages go by without an eye-opening fact, an intriguing fresh perspective or the demolition of a common misconception. It boggles the mind, for example, to learn that more concrete was poured in China in the three years to 2010 than in the USA in the entirety of the 20th century. Who would have thought that 75% of Indian households still use dung for cooking? And how astonishing that the amount of energy embodied in the production of mobile phones, per year of use, exceeds that of car production. One of the insights which flows from the book's epic historical sweep is just what a fundamental shift the Industrial Revolution represents. Despite all the technological advances in earlier centuries, what is striking is how many of the prime movers, fuels and basic farming practices persisted largely unchanged through millennia of preindustial civilization, and how radically the world's energetic foundations have subsequently been transformed by massive subsidies of fossil energy from the deep past. Until the late 18th century, for example, it was still true - as in antiquity - that the fastest mode of overland travel was riding a good horse, and that indoor lighting 'came only in units of one candle' (p.177). But then a new world was created in just a handful of generations.

Given Smil's lifetime focus on energy, it must be tempting for him to view everything through an energy lens and to tie all explanations back to energetics, but this temptation he explicitly resists: 'the explanatory power of an energy approach to history must not be exaggerated' (p.418). Where the imperatives of energy needs and uses were instrumental in shaping the course of history, he presents the evidence persuasively, but he is the first to acknowledge that there are many other history-shaping factors, from climate to epidemics to human passions. He is thus strongly critical of the energy-civilization equation which simplistically equates high energy use with a high level of civilization, dubbing it 'energetic determinism'. He argues, in fact, that rising energy use guarantees nothing except increasing environmental impacts. He also writes with sober realism about the monumental challenge that we face in breaking our systemic addiction to fossil fuels which still account for 86% of the world's primary energy, and how many generations it may actually take to achieve it. But he also comments wryly that the most common trait of energy forecasts is a failure to foresee.

Smil's encyclopaedic grasp of the subject matter is, naturally, a great strength of the book. The text is a veritable mine of factual information, packed with facts, figures, statistics and technical details. But in one regard this is also a weakness. The factual overload makes it a dense read which is somewhat lacking in the human touch, notwithstanding some interesting discussions of the relationships between energy and quality of life. We learn all about the precise technical and scientific ways in which energy shaped and constrained societies, but less about the impacts of all these innovations and transitions on ordinary human lives. Nor do we learn anything about the lives and motivations of the key figures in the story, the likes of Watt, Edison and Daimler whose inventions transformed the world. No book can do everything, of course. But even a slight shift from the numerical towards the human experience, plus some biographical snippets, would have helped to humanize the text. Overall, however, this is a magisterial, clear-sighted book, the fruit of decades of research and reflection, which successfully paints the fine brushstrokes of technical detail onto the broad canvas of history. It will surely stand as the definitive work on this crucial subject for years to come.

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